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NATIONAL DAM SAFETY PROGRAM. LOWER NORTH RIVER DAM NUMBER 80 (V--ETC(U)
SEP 78 M BAKER DACW65-78-D-0016

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(1) POTOMAC RIVER BASIN

Name Of Dam: (2) LOWER NORTH RIVER NO. 80

Location: (5) ROCKINGHAM COUNTY, STATE OF VIRGINIA

(3) **Inventory Number:** VA 16501

AD A063575

LEVEL II

PHASE I INSPECTION REPORT

(6) NATIONAL DAM SAFETY PROGRAM

Lower North River Dam Number 80 (~~Inventory Number~~ VA 16501). Potomac River Basin. Rockingham County, State of Virginia. Phase I Inspection Report.

(9) Final rpt.,

(10) Michael Baker, III

(11) Sep 78

(12) 69 P.

(15) DACW65-78-D-0016

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NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

SEPTEMBER 1978

BY

MICHAEL BAKER, JR., INC.

BEAVER, PENNSYLVANIA 15009

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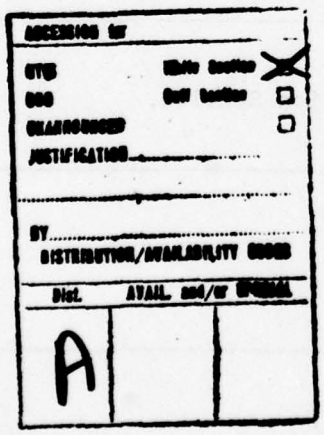
20. Abstract

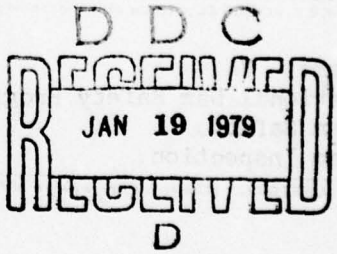
Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

LEVEL II





PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lower North River No. 80
State: Virginia
County: Rockingham
Stream: Union Springs Run
Date of Inspection: 13 June 1978

BRIEF ASSESSMENT OF DAM

Lower North River Dam No. 80 is an earth dam approximately 81.7 feet high and 925 feet long, owned and operated by Funk, Stickley and Crousborn. The dam was designed by the U.S. Soil Conservation Service on Union Springs Run as part of the Potomac River Watershed Project. The visual inspections and review of engineering data, made in July 1978, indicate no serious deficiencies requiring emergency attention.

The emergency spillway will pass the Probable Maximum Flood without overtopping the dam. Stability analyses done for the dam design showed a sufficient factor of safety; however, a small clear seep was discovered on the downstream face of the dam approximately 10 feet to the right of the outlet pipe. The clear seep may affect the embankment stability. Although the flow from the clear seep was less than one-half g.p.m. at the time of inspection, the flow rate could increase as the reservoir level rises.

It is recommended, therefore, that the clear seep be monitored especially during periods of high reservoir levels to determine if the flow through the clear seep increases. If the flow rate does increase, a more thorough investigation and possibly remedial measures will be necessary. It is also recommended that tree removal, seeding, handrail repair, and lift gate checks be done as part of the annual maintenance program.

MICHAEL BAKER, JR., INC.

Michael Baker, III, P.E.
Chairman of the Board and
Chief Executive Officer

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Colonel, Corps of Engineers
District Engineer

Date: SEP 20 1978

OVERALL VIEW OF DAM

OVERALL VIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: LOWER NORTH RIVER NO. 80 ID# VA 16501

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams. The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Description of Project

1.2.1 Description of Dam and Appurtenances: Lower North River Dam No. 80 is an earthfill structure approximately 925 feet long and 81.7 feet in height. The crest is 24 feet wide and was established at elevation 1606.7 feet above Mean Sea Level (M.S.L.). Side slopes on the dam are two and one-half horizontal to one vertical (2.5:1). The upstream slope is interrupted by a 10 feet wide, gently dipping erosion control berm at approximate normal pool level.

The dam was constructed by excavating an 80 feet wide cut-off trench, which underlies the upstream side of the structure, into shale, siltstone and sandstone bedrock. The primary fill materials consist of silty and clayey gravels (GM & GC). The lower 20 feet of the downstream side of the dam is constructed from silty gravels (GM).

The principal spillway (see Photo 1) consists of a 30 inch reinforced concrete pipe served by a drop-inlet structure (riser) located in the original stream valley and at the upstream

toe of the dam (see Photo 2). The low stage crest of the riser is at elevation 1553.5. The high stage riser crest is at elevation 1581.5. A 30 inch slide gate is located at the northern base of the riser with the invert at elevation 1532.0.

A side-channel emergency spillway, cut into rock and covered with a thin compacted earth-fill, is situated on the south side of the dam (the spillway appears in background of Photo 2). The spillway is 200 feet wide at its base with 3:1 side slopes. The crest of the spillway is at elevation 1599.0. The approach channel slopes upward toward the emergency spillway crest at a grade of 0.2 percent. A 30 feet long flat section forms the crest, and the discharge channel slopes away at a 0.3 percent grade.

A plan view of the dam, plan and profile of the cut-off trench, and profile along the principal spillway which shows a typical dam cross section are included in this report as Plates 1, 2 and 3, respectively.

1.2.2 Location: Lower North River Dam No. 80 is located in Rockingham County, Virginia along Union Springs Run. Union Springs Run is a tributary to Beaver Creek which drains into the North River. The dam is situated approximately 3.5 miles upstream from Ottobine, Virginia.

1.2.3 Size Classification: The dam is classified as "intermediate" size in accordance with the Recommended Guidelines for Safety Inspection of Dams based on a height of 87 feet and a storage capacity of 1016 acre-feet.

1.2.4 Hazard Classification: Approximately 25, scattered, permanent residences are situated immediately downstream from the subject impoundment. No significant industrial developments are located close to the area of influence. Based on Section 2.1.2 of the Recommended Guidelines for Safety Inspection of Dams, Lower North River Dam No. 80 is given a "high" hazard classification. The hazard classification used to categorize dams is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: The apparent owners of the dam are Funk, Stickley and Crousborn.

1.2.6 Purpose of Dam: The facility was designed for flood control.

1.2.7 Design and Construction History: The facility was designed by the U.S. Soil Conservation Service (S.C.S.). The design documents are dated 1965. Construction was done by R. L. Ryder and Co. and was completed in 1967.

1.2.8 Normal Operational Procedures: Operation of the dam is an automatic procedure. The normal pool is controlled by a low stage orifice on the concrete riser which measures 18 inches high and 20 inches wide. The invert of this orifice is at elevation 1553.5. The reservoir level rises when the flow capability of this orifice is exceeded until it reaches elevation 1581.5, which corresponds with the high stage riser crest. Water will flow into the riser over this crest until the capacity of the principal spillway is exceeded. The reservoir level will rise an additional 17.5 feet above the riser crest before water will flow through the emergency spillway. There is a one percent chance each year that the emergency spillway will be used.

Maximum low stage flow through the principal spillway, which corresponds to reservoir levels below the elevation of the riser crest, is 68 c.f.s. Maximum high stage flow, where the reservoir level would be at the elevation at the crest of the emergency spillway (1599.0), is 152 c.f.s.

1.3 Pertinent Data

1.3.1 Drainage Area: The dam controls a drainage area of 5.19 square miles consisting of steep wooded mountain terrain.

1.3.2 Discharge at Dam Site: The maximum flood at this dam site is unknown.

Principal Spillway:

Pool level at emergency spillway crest	152 c.f.s.
Pool level at top of dam . .	159 c.f.s.

Emergency Spillway:

Pool level at top of dam . .	12,680 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in the following table:

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet M.S.L.	Reservoir Area acres	Reservoir Capacity Acre-feet	Reservoir Capacity Watershed inches(a)	Length feet
Top of dam	1606.7	50.5	1345	4.86	-
Maximum pool, design surcharge	1602.9	46.5	1180	4.26	3170
Emergency spillway crest	1599.0	41.7	1016	3.67	2640
Principal spillway crest	1581.5	23.3	462	1.67	2110
Low stage orifice crest (b)	1553.5	6.8	52	0.19	1060
Streambed at centerline of dam	1525.0	-	-	-	-

(a) Based on 5.19 square miles of watershed.
(b) Top of conservation pool and bottom of flood control pool.

SECTION 2 - ENGINEERING DATA

2.1 Design: The design data reviewed included the following:

1) As-built drawings indicating plans, elevations and sections of the dam, and appurtenant structures. (Logs of test pits and test borings were also included in the as-built drawings.)

2) Hydrologic and hydraulic data.

3) Soils and Geologic Reports (Geologic Report is presented in Appendix VI).

4) Soil test results.

5) Slope Stability Analyses (Appendix VII).

6) Piping and Cracking Analysis (Appendix VIII).

All data has been submitted to the Norfolk District for future reference.

2.2 Construction: The dam was constructed by R.L. Ryder and Co. and was completed in 1967. Construction records were not available for this inspection, but are reported to be file at the S.C.S. Office in Washington, District of Columbia.

2.3 Operation: There are no formal operating procedures for this dam. The slide gate used to drain the reservoir is not periodically operated. Records of spillway flows were not available. Annual inspections are carried out by the District Conservationist of the S.C.S.

2.4 Evaluation

2.4.1 Design: The Stability Analyses and as-built drawings were adequate for evaluating the structural stability of the dam. Foundation conditions were determined using the Geologic Report. The hydrologic and hydraulic data provided were adequate for design review.

2.4.2 Construction: No construction records were available; however, the as-built drawings indicate modifications and changes made during construction.

2.4.3 Operation: Operation of the slide gate should be included in the annual maintenance and inspection program.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

3.1.1 General: The field inspection was conducted on 13 July 1978. No unusual weather conditions were experienced, and the water level was 0.6 foot above the low stage crest of 1553.5. The dam and appurtenant structures were found to be in good overall condition at the time of the inspection. The problems noted during the visual inspection are considered minor, with the exception of the clear seep on the downstream embankment, and do not require immediate remedial treatment. Noteworthy deficiencies observed are described briefly in the following paragraphs. The complete visual inspection check list is given in Appendix III.

3.1.2 Dam: A small clear seep (person in Photo 1 is standing at location of clear seep) was noted on the downstream face of the dam at an elevation of 1526.5 located approximately ten feet to the right of the outlet pipe. Flow at the time of the visual inspection was estimated at less than one-half g.p.m. However, a six inch wide by two inch deep erosion channel, which indicates possible higher intermittent flows, had formed immediately below the origin of the clear seep. A fifteen feet by three feet marshy area is also present about one or two feet in elevation immediately down slope of this clear seep. This marshy area may be related to the above clear seep.

Minor erosion damage was observed during the visual inspection. A ten feet wide shallow eroded footpath was observed leading from the dam crest to the water edge down the center of the upstream side of the dam (see Photo 3 and Overall View of Dam). Minor erosion is also occurring along the downstream dam abutments due to runoff. Riprap had not been placed on the erosion control (wave dissipation) berm at normal pool level on the upstream embankment (see Photo 2). Consequently, this berm has eroded slightly due to water level fluctuations, wave action and pedestrian traffic.

No sloughing of the embankment or additional seepage and/or erosion problems, related directly to the dam, were noted during the field investigation. Only a few very small trees were observed growing on the downstream embankment (see Photo 1). The vegetative cover on the dam consists of dense low grasses or brush which has been kept mowed to a height of 36 to 48 inches (see Photo 3 for typical vegetation). Some logs and miscellaneous debris have collected on the upstream side of the dam.

Erosion is occurring on the access road which ascends the south slope of the emergency spillway. Minor sedimentation results on the south side of the spillway discharge channel, which could clog the corrugated metal pipe that passes beneath the road. This pipe handles surface drainage from a small section of the spillway lying upstream of the road.

3.1.3 Appurtenant Structures: At the time of the inspection, debris was lodged in the trash rack several feet above the normal pool level.

The inlet and outlet structures were found to be in good condition with the exception of one section of handrail missing from the ladder on the riser.

3.1.4 Reservoir Area: No serious shoreline or gully erosion was observed.

3.1.5 Downstream Channel: The stilling basin is approximately four feet deep and is mostly formed by a cut into hard bedrock with some riprap near the spillway outlet. No signs of significant erosion were observed.

3.2 Evaluation

3.2.1 Dam: None of the aforementioned items, with the exception of the clear seep noted at the base of the downstream embankment are serious enough to warrant immediate investigation. Rather, these items can be taken care of during an annual maintenance and inspection program.

At the time of the visual inspection, the elevation of the clear seep was 27.6 feet lower than the reservoir level. The exact source of the clear seep could not be determined by visual inspection alone. However, the following two possibilities exist:

1) The clear seep could be due to a buildup of water perched on the silty and clayey gravel used as embankment material for the construction of the dam. The water, in this case, would be surface water that has percolated into the fill and is surfacing much like a spring because the impermeable materials prevent further downward water migration.

2) The clear seep could be a result of water leaking from the reservoir through the embankment.

If the clear seep is originating from the reservoir, the flow rate will likely increase as the reservoir rises. The clear seep should be monitored during periods of high reservoir levels to determine if the flow rate increases. If it is determined that the flow is originating from the reservoir, a more detailed investigation including a test boring program and installation of piezometers would be necessary to determine the dam's phreatic surface and the source of the clear seep.

The following dam maintenance items are suggested:

1) The small trees growing on the embankment should be removed.

2) The footpath on the upstream face of the dam should be repaired and reseeded, or a type of stairway should be constructed to prevent future damage.

3) The erosion channels along the downstream dam abutments should be filled and reseeded.

3.2.2 Appurtenant Structures: The trash rack should be inspected; and debris should be removed periodically from it, particularly during the heavy rainfall seasons. The upper handrail section on the riser access ladder should be replaced.

3.2.3 Reservoir Area: The reservoir area does not require further investigation.

3.2.4 Downstream Channel: The downstream channel does not require further investigation.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: No formal operational procedures are used on the Lower North River Dam No. 80, since it is a flood control structure and does not require the use of water supply intake valves or gates. The reservoir under normal conditions remains at an elevation of normal pool of 1553.5 and has 28.0 feet of additional storage to the crest of the high stage riser (1581.5) plus an additional 17.5 feet of storage to the crest of the emergency spillway (1599.0) (see Photo 2).

4.2 Maintenance of Dam: Annual inspections are carried out by the District Conservationist of the S.C.S.

4.3 Maintenance of Operating Facilities: The lift for the slide gate is not routinely checked to verify proper functioning.

4.4 Warning System: At the present time, there is no warning system or evacuation plan in operation.

It is recommended that a formal emergency procedure be prepared, and prominently displayed and furnished to all operating personnel. This should include:

1) How to operate the dam during an emergency.

2) Who to notify, including public officials, in case evacuation from the downstream area is necessary.

3) Procedures for evacuating inflow during periods of emergency operation.

4.5 Evaluation: Maintenance of the operating facilities are considered adequate for the functions that they serve. However, formal lift gate checks should be instituted as part of the annual inspections.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: The elevation of the low stage crest (elevation 1553.5) of the drop-inlet to the principal spillway was established at an elevation which would provide the storage necessary for sediment deposits during a 100 year design period with a 90 percent trap efficiency. The high stage crest (elevation 1581.5) was established based upon a number of factors including:

1) The capability of evacuating the flood storage space within a reasonable period of time (± 10 days).

2) Not passing damaging flows downstream.

3) The capability of the reservoir to store the flood waters.

The capacity of the combined low stage and high stage inlets is 152 c.f.s. when the water surface is at the elevation of the emergency spillway (1599.0) and is controlled by the capacity of the 30 inch diameter outlet conduit. The crest of the emergency spillway (elevation 1599.0) was established at the maximum elevation required to store the 100 year, 10 day duration rainfall. The elevation of the top of the dam (elevation 1606.7) was established by the maximum elevation reached in passing the freeboard hydrograph. This hydrograph is computed from rainfall comparable to the Probable Maximum Precipitation (P.M.P.) as used by the Corps of Engineers and is therefore comparable to the Probable Maximum Flood (P.M.F.).

5.2 Hydrologic Records: None

5.3 Flood Experience: None

5.4 Flood Potential: Design features of the dam were established by routing various hydrographs as noted in Paragraph 5.1.

5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1, paragraph 1.3.3.

The regulation of flows from this reservoir is automatic. Water rising to an elevation below the high stage inlet (elevation 1581.5) flows through the low stage inlet (elevation 1553.5; while water rising to an elevation above 1581.5 flows through the high stage inlet. Both inlets are part of the concrete riser which outlets through a 30 inch concrete conduit. In the event that the elevation of the crest of the emergency spillway

(elevation 1599.0) is exceeded, water will then also flow past the dam through the ungated emergency spillway.

Outlet discharge capacity, reservoir area and storage capacity, and hydrograph and routing determinations were obtained from reports and computations furnished by the S.C.S.

5.6 Overtopping Potential: The probable rise in the reservoir and other pertinent information on reservoir performance in various hydrographs is shown in the following table:

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Normal	Hydrographs: Principal Spillway (a)	Hydrographs: Emergency Spillway	Hydrographs: Freeboard (b)
Peak flow, c.f.s.				
Inflow	-	-	4655	12,680
Outflow	-	152	3895	12,512
Peak elev., ft. M.S.L.	1553.5	1599.0	1602.9	1606.7
Emergency spillway				
Depth of flow, ft.	-	-	3.9	7.7
Avg. velocity, f.p.s.	-	-	8.3	12.1
Non-overflow section				
Depth of flow, ft.	-	-	-	-
Avg. velocity, f.p.s.	-	-	-	-
Tailwater elev., ft. M.S.L.	-	-	-	-

(a) 100 year, 10 day volume produces the most conservatively large indication of flood control storage required. Detailed discharge hydrograph was not determined.
(b) Freeboard hydrograph developed from rainfall essentially equal to P.M.P. by C.O.E. standards.

5.7 Reservoir Emptying Potential: With the reservoir level at the emergency spillway crest elevation, the high stage inlet on the riser has a maximum discharge capability of 152 c.f.s. When the reservoir level decreases to the crest elevation of the high stage inlet, the low stage inlet has a maximum discharge of 68 c.f.s. Considering these discharges and the reservoir storage, the total drawdown time from the emergency spillway crest to normal pool is 7.51 days. The 30 inch corrugated

5.8 Evaluation: Hydrologic and hydraulic determinations as prepared by the S.C.S. appear reasonable. The dam and spillway are designed to pass a flood essentially equal to the P.M.F., which is in accordance with the Recommended Guidelines for Safety Inspection of Dams. The project would pass the P.M.F. without overtopping the dam.

It should be indicated that conclusions pertain to present day conditions, and that the effect of future development on the hydrology has not been considered.

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: Alluvial sand and gravel, and colluvial sand, silt and minor amounts of clay blanket the bedrock at the centerline of the dam. The shale and sandstone underlying the valley fill has a thin weathered zone generally less than one foot thick. Part of the upstream side of the dam is seated in a cut-off trench excavated into the above bedrock which is mostly 80 feet in width at the base, narrowing to not less than 12 feet at the ends of the dam. Plate 2 of this report shows the details of the cut-off trench as well as summarizing test pit information along the centerline of the cut-off trench. The remainder of the dam was placed on the natural soils. Both abutments are underlain by very fine silty sandstone and shale. The left abutment has a very thin soil cover, and the right abutment has a cover of three to eight feet of silty, weathered-rock material. Exposed bedrock at the road cut immediately above the northern dam crest strikes N.30°-40°E., very nearly parallel with the crest of the dam, and dips steeply southeast (downstream) at 50°-55°.

6.2 Stability Analysis

6.2.1 Visual Observations: No tension cracks, sloughing of the embankment slopes, movement at or beyond the toe, or other evidence of instability was observed. The dam has been well maintained and is not significantly eroded or overgrown. The upstream and downstream slopes of the dam were constructed at 2.5:1 slopes.

Clear seepage was observed near the downstream toe of the dam, as explained in paragraph 3.1.2, at approximately elevation 1526.5. The dam seep is located seven feet above the invert of the principal spillway outlet and approximately 10 feet to the right of this conduit. (The person appearing in Photo 1 is standing near the clear seep). This discharge amounted to less than 0.5 g.p.m. at the time of the visual inspection. A fairly wide marshy area lies immediately below this clear seep. It is uncertain, at this time, whether the seep and marsh are fed by reservoir water.

6.2.2 Design Data: Slope stability was checked by the Swedish Circle Method. The section considered was not zoned and indicated that the embankment would consist of a material classifying it as silty gravel (GM) according to the Unified Classification System. Three consolidated undrained triaxial shear tests were performed on samples of the embankment soil. The following strength parameters were obtained and used for the Stability Analyses:

Embankment Soil Samples

Sample No. 1 . . . $\bar{\phi}$ = 32.5°, $\bar{c}$ = 600 p.s.f.
Sample No. 2 . . . $\bar{\phi}$ = 30.5°, $\bar{c}$ = 675 p.s.f.
Sample No. 3 . . . $\bar{\phi}$ = 23.5°, $\bar{c}$ = 1050 p.s.f.

Minimum safety factors were obtained for failure of a floodplain section through 10 feet of foundation soil having an assumed shear strength of $\bar{\phi}$ = 32.5° and $\bar{c}$ = 0. The embankment soil was assumed to have Sample No. 1 shear strength values. A safety factor of 1.24 was obtained for a 2.5:1 upstream slope with a 10 feet wide berm assuming full drawdown. When the slope was changed to 3:1, a safety factor of 1.44 was obtained using the same arc. This analysis indicated the need for removal of foundation soils under the upstream slope accounting for the wide cut-off trench shown in the as-built drawings. A safety factor of 1.66 was obtained for a 2.5:1 downstream slope with a drain at c/b = 0.6.

A check of piping and cracking potential was also made. The gradations and plasticities of the expected embankment materials indicated that piping would not be a problem.

6.2.3 Operating Records: The yearly inspections indicated no deteriorating conditions. However, there was also no mention of the clear seepage on the downstream slope.

6.2.4 Post-Construction Changes: No alterations of the dam were apparent since its construction.

6.2.5 Seismic Stability: Lower North River Dam No. 80 is situated in Seismic Zone 2 and is considered to have no hazard from earthquakes according to the Recommended Guidelines for Safety Inspection of Dams.

6.3 Evaluation: The Stability Analysis for the upstream slope is compatible with as-built conditions. This analysis indicated the need for removal of the foundation soils; consequently, an 80 feet wide cut-off trench extending to firm bedrock was provided beneath the upstream slope.

The clear seepage on the downstream slope may indicate a phreatic line that exists on the downstream slope rather than terminating at the drain. A safety factor of 1.32 was obtained for the downstream slope when a Stability Analysis (the Stability Analyses performed as part of the design by the S.C.S.) was performed assuming steady seepage without a drain. If further observation indicates that the clear seepage is originating from the reservoir, additional stability analyses should be made using the existing phreatic surface.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: The dam is designed to prevent overtopping under P.M.F. conditions. One clear seep was observed on the downstream face. The consequences of this clear seep depend on whether the source of water is the reservoir or infiltration on the embankment crest and slopes, and the effect of the clear seepage on embankment stability. There is a potential for piping if the clear seepage originates from the reservoir.

The data available were sufficient to evaluate the adequacy of design. Data obtained during the inspection agrees very closely with the as-built drawings.

The dam will not require urgent remedial treatment. However, a regular observation schedule of inspecting the clear seep should be set up immediately to determine if the flow from the clear seepage increases with the resorvoir level.

Further investigation will be necessary if, after monitoring the clear seep, it is determined that the flow is originating from the reservoir.

7.2 Recommended Remedial Measures

7.2.1 Clear Seep: Immediately, the owner should set up and maintain a regular observation schedule of inspecting the clear seep, during higher reservoir levels, to determine its source, prevent erosion and prevent a worsening condition from going unobserved. If as a result of these periodic inspections it is found that the flow is originating from the reservoir, then an in-depth investigation including a test boring program and piezometers is recommended. An inverted filter may be needed to prevent piping if the source of the clear seep is determined to be the reservoir.

7.2.2 Other Recommendations: The lifting mechanism on the discharge valve should be checked for normal operation at each inspection. If not working, it should be repaired. The handrail on the riser ladder should be repaired. The trash rack should be cleaned of debris and cleaned frequently in the future.

All small trees growing on the embankment should be removed. The footpath on the

upstream face of the dam should be graded and reseeded or a type of stairway should be constructed to prevent future damage. Also, the erosion channels along the downstream dam abutments should be filled and reseeded. These items can be accomplished through the annual maintenance program.

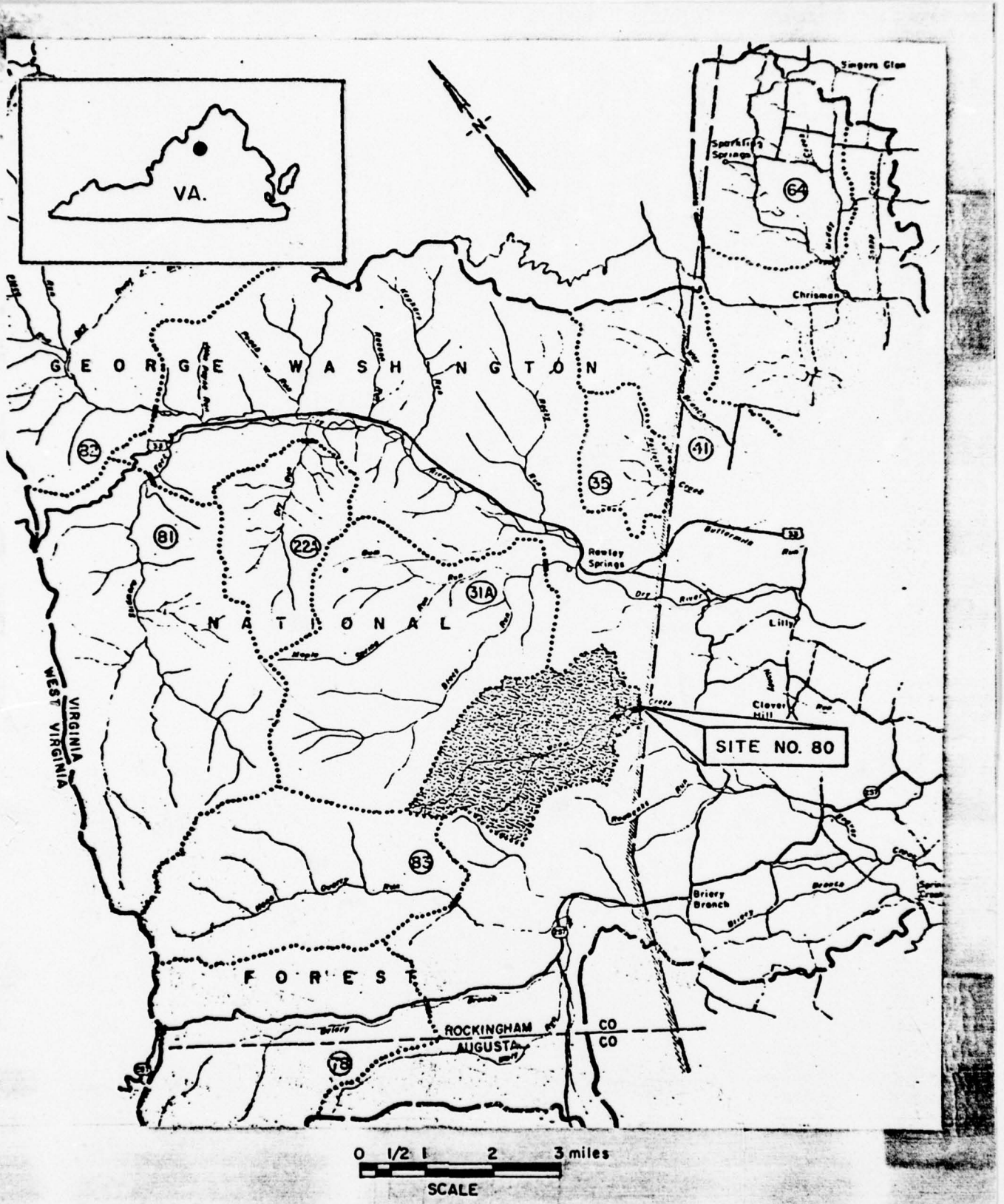
A warning system should be devised that will alert downstream occupants to evacuate when the reservoir level approaches the top of the embankment. The downstream occupants should also be advised to evacuate during storms that coincide with the U.S. Weather Bureau's flashflood warning system.

APPENDIX I

PLATES

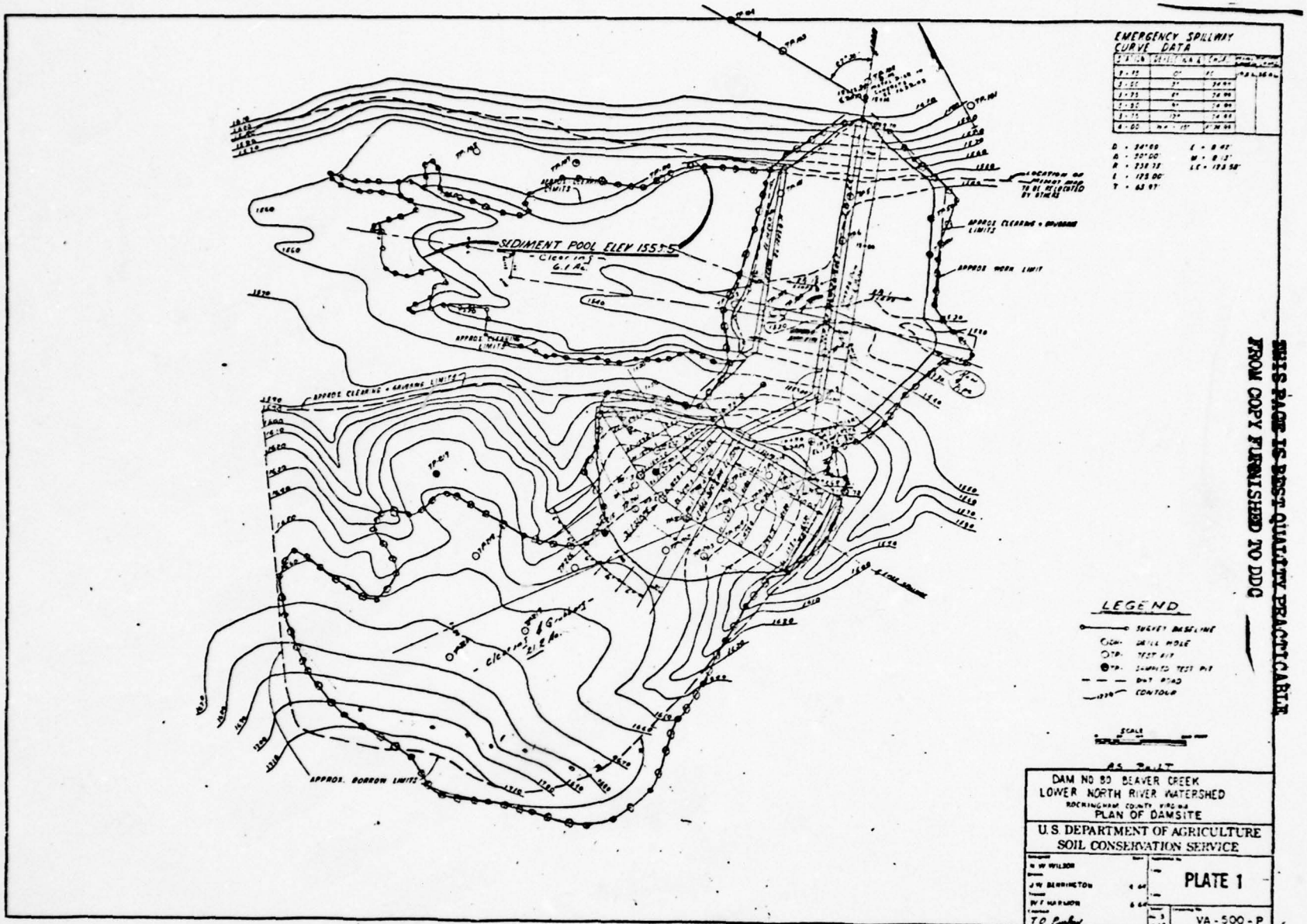
CONTENTS

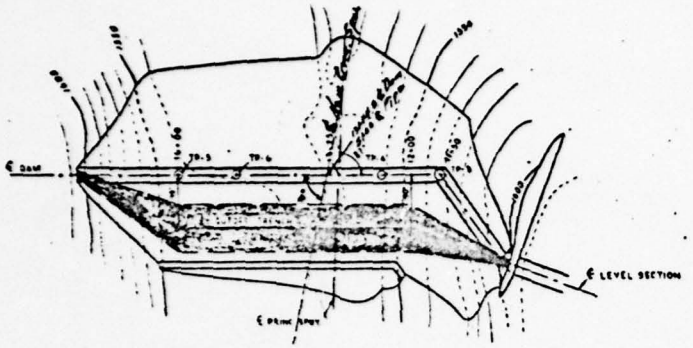
NAME OF DAM: LOWER NORTH RIVER NO. 80



LOCATION PLAN

LOWER NORTH RIVER No. 80

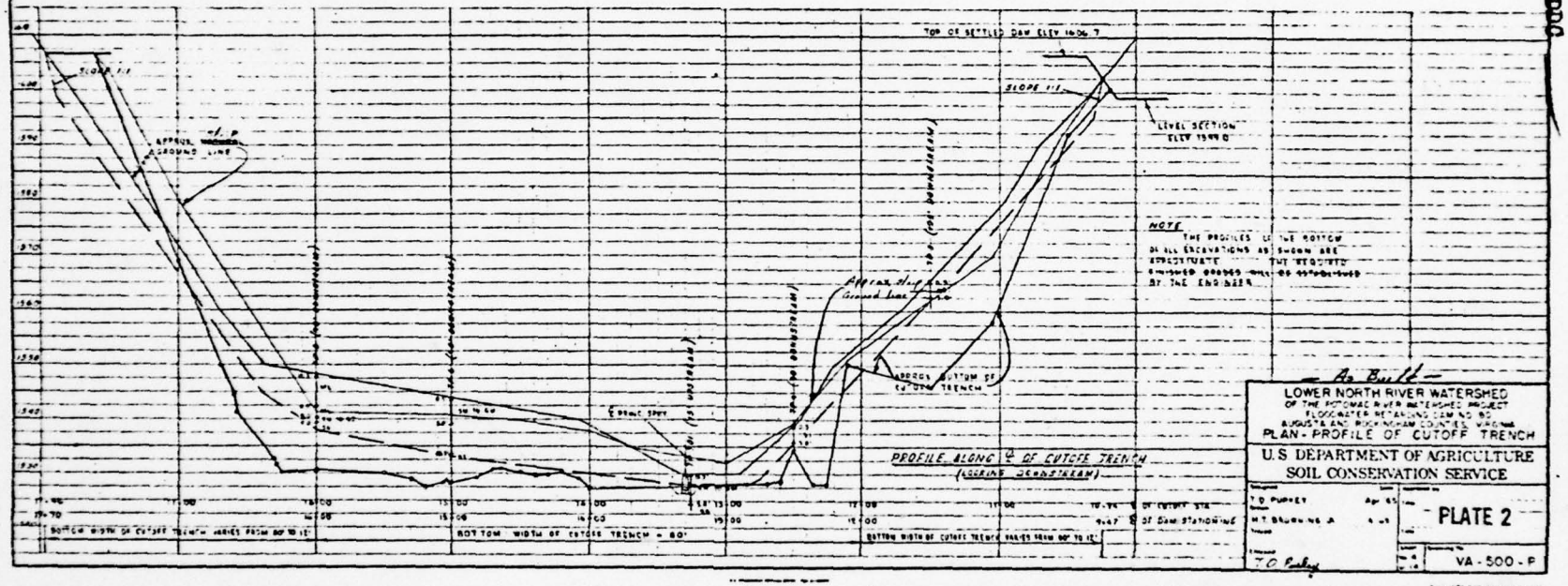




PLAN OF CUTOFF TRENCH

SCALE 0 100 200 FT.

TYP. SECT. OF CUTOFF TRENCH



PROFILE ALONG ℄ OF CUTOFF TRENCH
(LOOKING DOWNSTREAM)

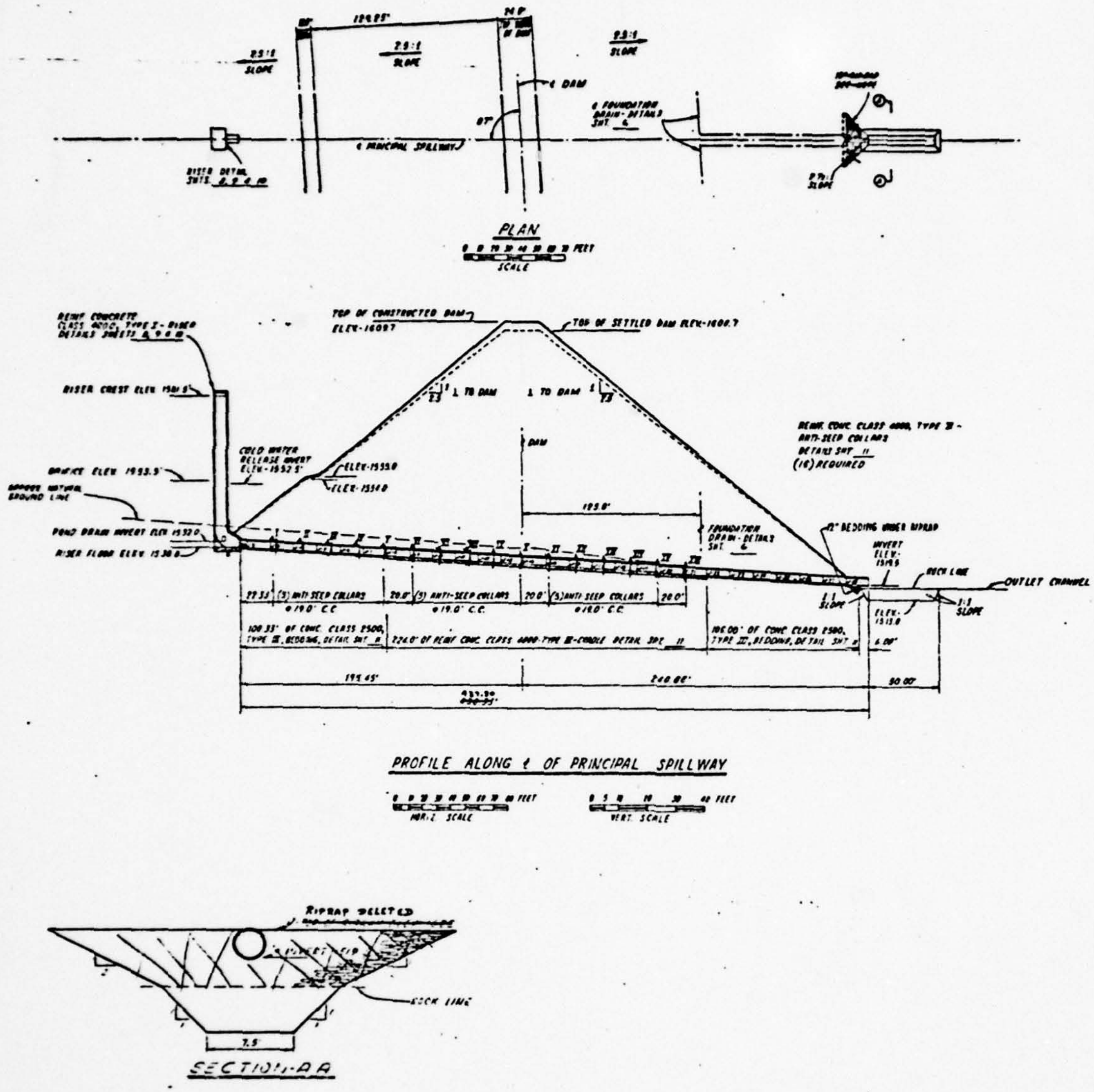
NOTE
THE PROFILES OF THE BOTTOM OF ALL EXCAVATIONS AS SHOWN ARE APPROXIMATE. THE REQUIRED FINISHED GRADES WILL BE ESTABLISHED BY THE ENGINEER.

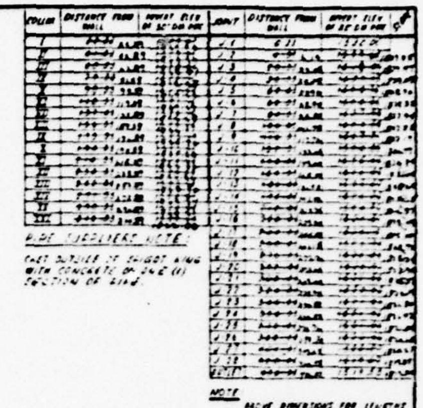
— As Built —

LOWER NORTH RIVER WATERSHED
OF THE POTOMAC RIVER WATERSHED PROJECT
FLOODWATER RETARDING DAM NO. 50
AUGUSTA AND ROCKINGHAM COUNTIES, VIRGINIA
PLAN - PROFILE OF CUTOFF TRENCH

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed T.D. PURKEY	Date Apr. 65	Title PLATE 2	
Traced M.T. BROWNING JR.	Scale 1" = 5'		
Approved T.C. Purkey		Drawing No. VA - 500 - P	





NOTE: ABOVE DIMENSIONS FOR LENGTHS OF PIPE ARE BASED ON NOMINAL LENGTHS & DO NOT INCLUDE CREEP

30" INSIDE DIA REINF CONC WATER PIPE
(27) SECTIONS
(1) SECTION
(1) WALL FITTING FOR 15" WALL

TOTAL LENGTH = 433.80
PRESSURE HEAD = 33.98'

J-1 TO J-8 & J-27 TO OUTLET
LOAD = 47,100 LBS PER LIN FT BASED ON O.D. OF 3.17'
MIN 3 EDGE BEARING STRENGTH FOR 0.01" CRACK (NON-PRESTRESSED PIPE) = 27,750 LBS/LIN FT AWWA C300
MIN 3 EDGE BEARING STRENGTH FOR 0.001" CRACK (PRESTRESSED PIPE) = 16,150 LBS PER LIN FT AWWA C301

J-8 TO J-27
LOAD = 50,500 LBS PER LIN FT BASED ON O.D. OF 3.33'
MIN 3 EDGE BEARING STRENGTH FOR 0.01" CRACK (NON-PRESTRESSED PIPE) = 30,300 LBS PER LIN FT AWWA C300
MIN 3 EDGE BEARING STRENGTH FOR 0.001" CRACK (PRESTRESSED PIPE) = 22,900 LBS PER LIN FT AWWA C301

~~RIPRAP NOTE~~: DELETED

BEDDING SHALL MEET THE GRADATION REQUIREMENTS FOR FILTER MATERIAL AS SHOWN ON SHEET 6.

AS BUILT

LOWER NORTH RIVER WATERSHED
OF THE POTOMAC RIVER WATERSHED PROJECT
FLOODWATER RETARDING DAM NO. 80
AUGUSTA AND ROCKINGHAM COUNTIES, VIRGINIA
PLAN - PROFILE OF PRINCIPAL SPILLWAY

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

T.O. PURSLEY Apr '65
C.B. FORD 5-64
TO Pursley

PLATE 3

VA-500-P

APPENDIX II

PHOTOGRAPHS

CONTENTS

Note: Photographs were taken 13 July 1978.

PHOTO 1. Principal Spillway Outlet - Stilling Basin

PHOTO 2. Concrete Riser Inlet Structure

PHOTO 3. Erosion on Footpath - Dam Crest to Water Edge

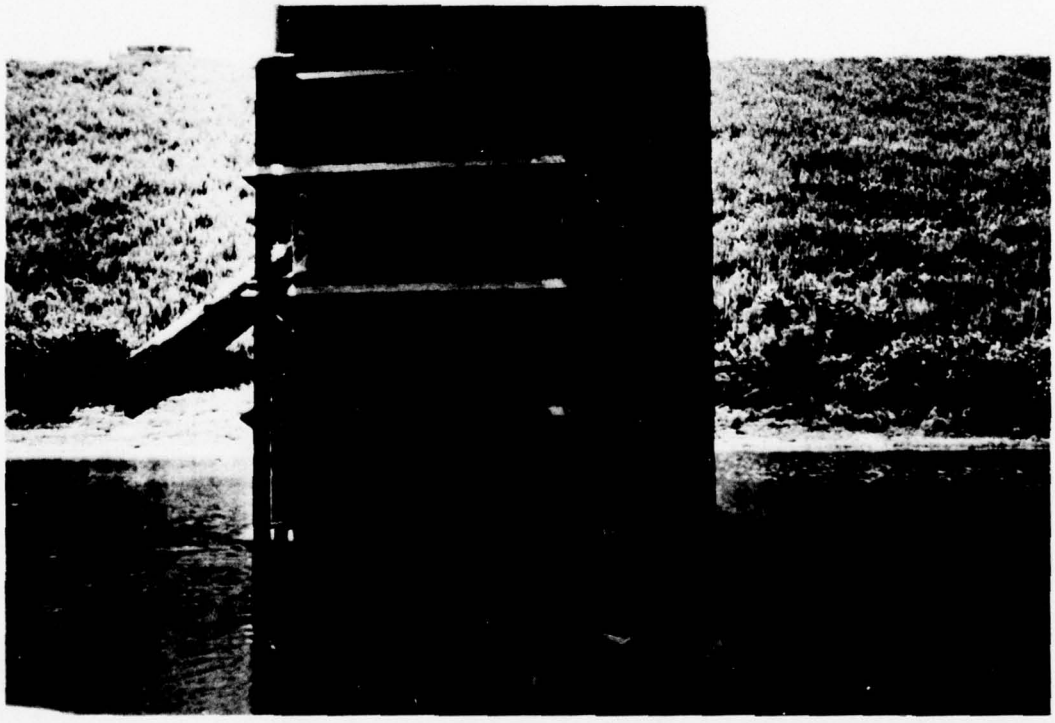


PHOTO 4. Debris in Low Stage Trash Rack

APPENDIX III

CHECK LIST - VISUAL INSPECTION

Check List
Visual Inspection
Phase 1

Name Dam Lower North River No. 80 (Union Springs Dam) County Rockingham State Virginia Coordinates Lat. 3828.3 Long. 7903.7

Date Inspection 13 July 1978 Weather Sunny Temperature 80° F.

Pool Elevation at Time of Inspection 1554.1 M.S.L. Tailwater at Time of Inspection 1514.9 M.S.L.

Inspection Personnel:

MICHAEL BAKER, JR., INC.:

Ed Brill
Michele Mill
David Hupe

VIRGINIA WATER CONTROL BOARD:

Tom Mizell

M. Mill Recorder

Lower North River No. 80

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No surface cracks were observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movement or cracking at or beyond the toe was observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing of the embankment and abutment slopes was observed. The dam appears to have been constructed with 2.5:1 slopes. Only a few small trees observed on the downstream slope. A wide eroded footpath (approximately 10 feet wide) was observed on the upstream slope. Some logs and debris have been deposited on the upstream slope.	The trees, logs and debris should be removed from the slopes. The footpath should either be repaired and reseeded to prevent further erosion a type of stairway should be constructed which will prevent future damage
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No bowing or bulging was observed. Elevations along the crest vary between 1608.1 and 1609.0 according to a level survey by Michael Baker, Jr., Inc.	
RIPRAP FAILURES	No riprap was used.	The erosion control berm on the upstream side of the dam at normal water level could use riprapping for protection.

EMBANKMENT

Lower North River No. 80

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No tension cracks were observed, but small erosion channels had formed at the downstream side of both embankment abutment contacts.	The erosion channels should be filled and reseeded. Paved gutters may be needed if erosion is not arrested.
ANY NOTICEABLE SEEPAGE	One seep was observed on the downstream slope of the dam at an elevation of 1526.5 feet. The seep is approximately 10 feet to the left of the outlet pipe when facing upstream. Flow from the seep was estimated at less than one-half g.p.m. at the time of the inspection. However, a six inch wide by two inch deep eroded channel had been formed by this flow indicating that it may have been stronger at one time. A 15 feet by three feet marshy area was observed on the bench immediately below the seep (one foot to two feet lower). The marshy area did not appear to be fed by the seep, nor did it appear to simply be an area of poor surface drainage.	The seep should be monitored during periods of high reservoir levels to determine if the rate of flow increase indicating the potential for dangerous piping.
STAFF GAGE AND RECORDER	There is none.	
DRAINS	Eight inch seepage drain outlets were observed on both sides of the outlet pipe. The clear flow from these seepage drains was estimated at one to two g.p.m. each. Seepage was observed around the right drain.	
FOUNDATION	Shale and interbedded thin layers of sandstone are extensively exposed at the northern dam abutment striking N. 30-40°E. and dipping SE. 50-55°.	

OUTLET WORKS

Lower North River No. 80

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None was found.	
INTAKE STRUCTURE	The concrete is in excellent condition. The metal parts show only slight rusting. The upper handrail section of the ladder is missing on one side.	Replace railing.
OUTLET STRUCTURE	No problems were found.	
OUTLET CHANNEL	Consists of a fairly straight channel through wooded area. A well formed plunge pool has formed and little further erosion is evident. The stilling basin consists primarily of an excavation into hard bedrock. Riprap was almost totally eliminated from the original plans because of this condition.	The outlet channel is in good condition.
EMERGENCY GATE	It appears to be in excellent condition above water and consists of a 30 inch diameter slide gate with its invert at elevation 1532.0. The gate will drain the reservoir.	Periodically test the emergency gate.

Lower North River No. 80

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Not Applicable	
APPROACH CHANNEL	The approach channel is covered by unmowed grass from 36 to 48 inches in height.	Keep the approach channel mowed.
DISCHARGE CHANNEL	Same as approach channel. Erosion is occurring on the access road which climbs the south slope of the emergency spillway. Minor sedimentation results on the south side of the spillway discharge channel. This sedimentation could clog a corrugated pipe which passes beneath the road to drain a small section of the spillway which lies upstream of the road.	Keep mowed. Erosion control should be investigated.
BRIDGE AND PIERS	There are none.	

Lower North River No. 80

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	A metal disk in the concrete is located above the left abutment at elevation 1632.03.	
OBSERVATION WELLS	There are none.	
WEIRS	There are none.	
PIEZOMETERS	There are none.	
OTHER		

Lower North River No. 80

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes appear to be steep and wooded. No sloughing was observed.	
SEDIMENTATION	Some heavy sedimentation in the form of sand was observed in the main stream channel entering the reservoir. The elevation of the reservoir bed surrounding the riser is approximately one foot below the invert of the reservoir drain slide gate.	

Lower North River No. 80

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel consists of a meandering channel primarily through pasture land.	
SLOPES	Only non-significant erosion was noted in a few areas.	
APPROXIMATE NO. OF HOMES AND POPULATION	There are approximately 25 dwellings located downstream. Ottobine School may also be affected.	

APPENDIX IV

CHECK LIST - ENGINEERING DATA

Lower North River No. 80

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	A complete set of as-built plans are available at the Norfolk District of the Corps of Engineers. A plan view of the dam is included in this report as Plate 1.
REGIONAL VICINITY MAP	The Location Plan is attached.
CONSTRUCTION HISTORY	No construction history was available for this inspection report. The S.C.S. design is dated 1965. Construction was completed in 1967.
TYPICAL SECTIONS OF DAM	Typical sections are presented in the as-built plans. A typical section is included in this report as Plate 3.
HYDROLOGIC/HYDRAULIC DATA	Hydrologic/hydraulic calculations (done by S.C.S.) were available for this inspection report.
OUTLETS - PLAN and DETAILS	are available at the Norfolk District.
- CONSTRAINTS and DISCHARGE RATINGS	are included in the S.C.S. design calculations and are available at the Norfolk District.
RAINFALL/RESERVOIR RECORDS	No rainfall or reservoir level records are available at the dam. Rainfall data is available from Virginia Climatologic records.

LOWER NORTH RIVER NO. 80

ITEM	REMARKS
DESIGN REPORTS	Hydraulic/hydrologic design calculations by the S.C.S. are available at the Norfolk District. A copy of the foundation and embankment design is also available at the Norfolk District.
GEOLOGY REPORTS	Logs of test borings and test pits are presented in the as-built drawings. A Geologic Report is attached as Appendix VI.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Design computations were done by the S.C.S. for hydrology and hydrauiics and dam stability. Stability Analyses are enclosed as Appendix VII. A piping and cracking analysis is enclosed as Appendix VIII.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	A foundation and borrow investigation was performed with test borings and pits. Soils have been classified both by visual field inspection and laboratory tests. Classifications are included in the design report.
POST-CONSTRUCTION SURVEYS OF DAM	The dam is inspected yearly by the S.C.S. District Conservationist.
BORROW SOURCES	The as-built drawings show borrow was acquired from the area of the spillway and the slope immediately southwest of the spillway.

Lower North River No. 80

ITEM	REMARKS
MONITORING SYSTEMS	Monitoring systems consist only of the riser.
MODIFICATIONS	No known major modifications have been made.
HIGH POOL RECORDS	No high water records are available. A high water mark was detected at approximately elevation 1565.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Yearly inspections are made by the District Conservationist of the S.C.S. No known major construction has been done since the dam was built.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	There were none.
MAINTENANCE OPERATION RECORDS	Yearly inspections are made by the S.C.S. It is obvious that maintenance is done regularly.

Lower North River No. 80

ITEM	REMARKS
SPILLWAY PLAN	
SECTIONS	This information is contained in the as-built drawings.
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Operating equipment at the site consists of a 30 inch diameter slide gate on the riser. Details are included in the design plans.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 5.19 square miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1553.5 (52 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1599.0 (1016 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: 1602.9 (1180 acre-feet)

ELEVATION TOP DAM: 1606.7 design elevation

CREST: Emergency spillway

a. Elevation 1599.0
b. Type Rock-cut side-channel
c. Width 200 feet
d. Length 440 feet
e. Location Spillover South side of dam
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 30 inch reinforced concrete pipe
b. Location Slightly south of center of dam
c. Entrance inverts Low stage riser crest elevation 1553.5, high stage crest elevation 1581.5
d. Exit inverts 1519.5
e. Emergency draindown facilities 30 inch diameter slide gate - invert elevation 1532.0

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Unknown

APPENDIX V

ANNUAL MAINTENANCE INSPECTION REPORTS

S... SHENANDOAH VALLEY SOIL AND WATER CONSERVATION DISTRICT

Report of Annual Maintenance Inspection of Watershed Dams in

LOWER NORTH RIVER WATERSHED PROGRAM

April 12, 1978

An inspection was made on 5 dam sites in Lower North River Watershed. Those present on the inspection were:

Gerald Fawley	Chairman District Board
James Moyers	Chairman Watershed Committee
Arlis Frymyer	District Director
John Crist	Soil and Water Conservation Commission
Don Parslow	U.S. Forest Service
Randy Maupin	Soil Conservation Service

The following observaions were made by members of the inspection party.

Site No.	Date Completed	Date of last Inspection	Remarks
22 B	4-67	4-23-77	Additional rail or large stone needed to control traffic in borrow area above spilway where new guard rails were placed. Work reported needed in Borrow Area C has not been completed.
81 C	10-75	-	Site in good condition. Suggest top of dam be fertilized at regular intervals to maintain grass stands.
80	3-67	4-20-77	Repairs needed on path that has been worn to waters edge on wet side of dam.
83	4-65	4-20-77	Vehicle traffic has worn off vegetation in several areas. No repair needed at this time.
78	11-65	4-20-77	Trash rack needs repair. Bolts broken that hold steel bars in place. Vegetation has been worn off by vehicle traffic in several areas but repairs not suggested at this time.

SHENANDOAH VALLEY SOIL AND WATER CONSERVATION DISTRICT
REPORT OF ANNUAL MAINTENANCE INSPECTION OF WATERSHED DAMS IN

LOWER NORTH RIVER, WATERSHED PROGRAM

May 28, 1976

On May 28, 1976 E. B. Craun, Shenandoah Valley Soil and Water Conservation District Director; Don Parslow, U. S. Forest Service; and Randy Maupin, District Conservationist Soil Conservation Service, made an annual maintenance inspection of the completed flood control structures in Rockingham County, Virginia.

The following observations were made by the members present on the inspection team:

Dam No. 78 -- Area between highway and lake has a steep bank that is sloughing off of approximately 1,000 square feet. It should be overseeded with a mixture of fescue and serecia lespedeza plus fertilizer.

Dam No. 83 -- Upper borrow area shows evidence of sheet erosion. Suggest that overseeding be done over the approximate 2 acres with a mixture of fescue and serecia lespedeza. Gully on south side of road at second waterbreak up stream from spillways. Forest service will take care of this problem.

Dam No. 80 -- On dry side of dam traffic is apparently stopped and it is felt that it will revegetate naturally. Foot path on wet side of dam near center is still getting traffic and will need further study to determine remedy.

Dam No. 22B -- Borrow area no. C has break in diversion also about ¼ acre bare of vegetation. This area needs attention as soon as possible. On dry side of dam jeep trail is still being used. Gate has not been installed, therefore, need to inquire as to status from city of Harrisonburg.

This report is concurred by:

E. B. Craun

E. B. Craun, Shenandoah Valley Soil and Water Conservation District Director

Randolph J. Maupin

Randolph J. Maupin, District Conservationist, Soil Conservation Service

Don Parslow

Don Parslow, United States Forest Service

DISTR: State Ofc.
Area Office
Rockingham Ofc.
U.S. Forest Service
Shenandoah Valley SWCD
City of Harrisonburg

Site No.	Date Completed	Date of last Inspection	Remarks
22 B	4-67	5-28-76	Vehicle traffic on the dry side of Dam has worn away vegetation. Vehicle traffic into borrow area east of the spillway has created two small gullies approximately 200 feet long. Traffic control and seeding needed. Borrow area C above the lake site has a break in berm and some bare areas above and below. 1/3 acres of revegetation needed.

Mr. Locker agreed that the City of Harrisonburg will assist the District with making the necessary repairs on this site.

This report is concurred by:

Carl B. Lively, Shenandoah Valley Soil and Water Conservation District

Gerald E. Fawley, Shenandoah Valley Soil and Water Conservation District

Harold H. Bush, Shenandoan Valley Soil and Water Conservation District

Don Parsiow, United States Forest Service

Randolph J. Maupin, District Conservationist, Soil Conservation Service

Edward Loker, City of Harrisonburg

SHENANDOAH VALLEY SOIL AND WATER CONSERVATION DISTRICT

Report of Annual Maintenance Inspection of Watershed Dams in

LOWER NORTH RIVER WATERSHED PROGRAM

April 20 and 23, 1977

On April 20, 1977 Carl Lively and Gerald Fawley, District Directors, and Randy Maupin, District Conservationist, Soil Conservation Service, made an annual maintenance inspection of Dam Sites #78, Briery Branch, #83, Hone Quarry, and #80, Union Springs. Don Parslow of the U.S. Forest Service was called on a forest fire and was unable to make the inspection tour with the group, but had visited site #78 and #80 recently.

The following observations were made by members of the inspection team:

April 20, 1977

Site No.	Date Completed	Date of last Inspection	Remarks
78	11-65	5-28-76	Area sited as needing seeding in last years report in stabilizing. Vehicle traffic is creating damage to outer slope of spillway. Seeding not needed at this time but control of traffic needed. Few large logs on wet slope of Dam should be removed.
83	4-65	5-28-76	Vehicle traffic on steep slopes in borrow area needs control. Few large logs on wet slope of Dam need removal.
80	3-67	5-28-76	Traffic near the center on the wet side of the Dam is continuing. Vegetation is being worn away. This is not a hazard to the structure at this time.

April 23, 1977

Dam #22 B was inspected by Harold H. Bush, District Director, Ed Locker, City of Harrisonburg, Don Parslow, U.S. Forest Service, and Randy Maupin, District Conservationist, Soil Conservation Service.

APPENDIX VI

GEOLOGIC REPORT

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

Kennedy
Holmes
Hunt
Fenner
Bechtel
Omaha
Rossier
Eley
Gain
NCE

GENERAL

State Virginia County Rockingham T. ___ R. ___ Sec. ___ Watershed Lower N. River

Subwatershed Beaver Cr. Fund assist. PP 303 Site number 80 Site group I Structure class C

Investigated by L. A. German Geologist (Supervisor and title) Equipment used Int. Track Mounted Backhoe (Type, size, make, model, etc.) Date 7/64

SITE DATA

Drainage area size 5.19 sq. mi., 3322 acres Type of structure Earth Fill Purpose Flood Prevention

Direction of valley trend (downstream) Southeast Maximum height of fill 80 feet, Length of fill 850 feet

Estimated volume of compacted fill required 70,000 yards

STORAGE ALLOCATION

	Volume (acre-feet)	Surface Area (acres)	Depth at Dam (feet)
Sediment	52	6.8	28
Floodwater	72	41.0	73

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Valley and Ridge Topography Mountainous Attitude of beds: Dip 30-50° SE Strike NE

Steepness of abutments Left 30-40 percent Right 10-30 percent. Width of floodplain at centerline of dam 380 feet

General geology of site The site is located on the east side of the mountain on the edge of the Valley and Ridge Physiographic province. The site is underlain by the Chemung formation of Upper Devonian age. The Chemung formation in this area is a fairly thickbedded, gray to greenish silty sandstone, and brown to gray shale.

UA 5006

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE Centerline of dam, principal spillway, emergency spillway, permanent

(Centerline of Dam, Principal Spillway, Emergency Spillway, Low Stream Channel, Investigations for Drainage, Borrow Area, etc.)

p361

DRILLING PROGRAM

Equipment used	Number of Holes: Exploration	Number of Holes: Sampling	Undisturbed Sample Taken: Volute Tubes	Disturbed Samples Taken: Large	Disturbed Samples Taken: Small
International Truck Mounted Backhoe				7	4
Total					

SUMMARY OF FINDINGS

(Include only factual data)

Centerline

The centerline is characterized by alluvial sand and gravel and colluvial sand, silt and minor amounts of clay. The gravel is composed of sandstone and siltstone pebbles to boulders with minor amounts of silt and clay. The alluvium would vary in classification from a CH to a GP with GM probably dominating. The bedrock underlying the valley fill has a thin weathered zone generally less than one foot thick. Both abutments are steep where they join the flood plain; the left abutment remains steep (30 - 40%) to beyond the proposed top of the dam. The right abutment becomes less steep as the spillway elevation is approached. The abutments are underlain by very fine silty sandstone and shale. The bedrock in the right abutment is more deeply weathered but unweathered bedrock is quite shallow -- 3 - 5' deep. Both abutments are well drained. The stream channel located against the right abutment is on bedrock for a several hundred feet above and below the centerline.

Principal Spillway

The foundation along the centerline of the principal spillway is on bedrock for its entire length. Test pit 303, located 200 feet upstream from the centerline of the dam, showed rock at 5.2 feet, test pit 302, located 150 feet upstream, showed rock at 5.8 feet and test pit 301 located 100 feet upstream showed rock at 5.8 feet. The rock in test pit 301 was 0.7 feet lower than the rock surface in stream at 13+65 on the centerline.

VA 5[illegible]8

Emergency Spillway

The emergency spillway is to be located in the right abutment. The material found in the test pit consisted of 3 to 12' of sandy silt to sandy clay with some silty sand and gravel present. Below this zone of silty material is weathered to unweathered siltstone, shale and very fine silty sandstone. The bedrock becomes quite firm but appears to be rippable. The borrow will be mainly ML and CL with minor amounts of SM, SC and GM. About 100,000 yards will be excavated from the emergency spillway cut.

Borrow Areas

The main borrow area is located in the abutment adjacent to the emergency spillway. The material to be excavated is similar to the material to be excavated from the emergency spillway area. The borrow will be mainly ML and CL with minor amounts of SM, SC and GM. Depths will range from 5-20+ feet. About 100-150,000 cu. yds. can be obtained from this area. More borrow could be taken from this abutment depending upon the amount needed.

Additional borrow will be obtained from the permanent pool area. A large quantity of borrow is available in the left side which would include the present road fill plus the colluvial material between TP - 110 and 111, and the left abutment which in places is 20 - 30 feet deep. This borrow would be ML to CL with some SM to GM. Approximately 40-50,000 cu. yds. of material is available from this area.

The left abutment is available for additional borrow. At present the plans are to move the present road up onto the ridge. If this is done, the material removed for the road cut could be used for the dam. Samples 104-1 and 107-1 are typical of the material present.

10-55

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

State Virginia County Rockingham Watershed Lower N. River Site name Beaver Creek

Site number 80 Site No. 1 Structure class C Investigated By L. A. Corman Geologist Date 8/64

INTERPRETATIONS AND CONCLUSIONS

For In-Service Use Only

1. Foundation conditions appear very adequate. Both abutments are covered with a thin soil mantle over weathered to unweathered bedrock. The weathered bedrock is very firm to hard.

2. The principal spillway is to be located along the right abutment. The stream channel is underlain by bedrock, so it was selected as the best location for the pipe. The channel is slightly braided upstream, so three test pits were necessary to get the best alignment. Good firm bedrock was located at about stream level for the entire length. Some rock excavation will be necessary because of some high ledges of rock near the centerline of the dam.

3. The flood plain material is quite varied but compact, so an impermeable core will be advisable. The material ranges from a CL to a GP with GM predominating. The depth the core trench is excavated into bedrock will vary according to the hardness of the rock excavated. Generally, a depth of one or two feet into the rock will be sufficient. The borrow from the area beyond the emergency spillway cut will make good core material.

4. The borrow material will be quite impermeable, so a foundation drain may be necessary.

5. The emergency spillway cut may require some rock excavation. A total depth of cut greater than 45 feet is required. Some very fine silty sandstone is present but the vertical or steep dipping strata may be all rippable. The quantity of rock excavation will be determined by core drilling to be done later. At present it appears that most of the shale siltstone and sandstone can be ripped with heavy equipment.

6. The abutments and spillway are dry and well drained, so no drainage in these areas is necessary.

7. Sufficient borrow is available at the site. Most of the borrow can be used anywhere in the dam. If flood plain borrow is too coarse it may be placed in the downstream section.

VA-500G.

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State Virginia County Rockingham Watershed Lower N. River

Subwatershed Beaver Cr. Purpose Class FP 503 Site number 80 Site type I

Investigated by L. A. Gorman Geologist Equipment used Int. Track Mounted Backhoe 10/64

SITE DATA

Drainage area size 5.19 sq. mi. 3322 acres Type of structure Earth Fill Purpose Flood Prevention

Direction of valley trend (downstream) Southeast Maximum height of fill 80 feet Length of fill 850 feet

Estimated volume of compacted fill required 290,000 cubic yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	32	6.8	25
Floodwater	78	41.0	75

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Valley and Ridge Topography Mountainous Attitude of beds Dip 30-50° SE Strike NE

Steepness of abutments Left 30-40 percent Right 10-30 percent Width of floodplain at centerline of dam 380 feet

General geology of site The site is located on the east side of the mountains on the edge of the Valley and Ridge Physiographic province. The site is underlain by the Chemung formation of Upper Devonian age. The Chemung formation in this area is a fairly thickbedded, gray to greenish silty sandstone, and brown to gray shale.

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10-69 DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE EMERGENCY SPILLWAY AND BORROW AREA

(Centerline of Dam, Principal Spillway, Emergency Spillway, Dike, Stream Channel, Investigations for Diversion of Stream, Borrow Area, Reservoir, Basin)

DRILLING PROGRAM

Equipment used	Number of Holes: Exploration	Number of Holes: Sampling	Undisturbed Samples Taken: (state type)	Disturbed Samples Taken: Large	Disturbed Samples Taken: Small
Sprague & Henwood #40 Core Drill	3				
Total					

SUMMARY OF FINDINGS

(Include only factual data)

Three holes were drilled in the proposed emergency spillway area. The holes were drilled on the outer edge of the proposed cut. DH #1 at 4+00 on outer edge was drilled 44 feet; DH #2 at 3+50 on outer edge was drilled 47 feet; and DH #3 at 3+00 on outer edge was drilled 37 feet. The depths were to grade or slightly below. During drilling it was determined that the material encountered was an interbedded siltstone and extremely fine sandstone, with some shale or claystone present. Very little core recovery was obtained. Hard layers of siliceous cemented material were present preventing any split spoon sampling, but yet too soft to allow good core recovery. The siltstone was mostly tan to light brown in color. This was indicated by the color of the drilling water. This siltstone is very tight and impermeable; no drilling water was lost during drilling operations.

DETAILED GEOLOGIC INVESTIGATION

State Virginia County Rockingham Watershed Lower N. River Name of Dam Beaver Creek

Site Number 80 Site group I Structure class C Designated by L. A. Gorman Geologist Date 10/64

INTERPRETATIONS AND CONCLUSIONS

IN-SERVICE USE ONLY

1. The drilling indicated that all of the material in the emergency spillway should be rippable. Some lenses and beds of harder siltstone may have to be classified as rock excavation due to the size of the broken material excavated; therefore, some quantity of rock excavation should be included.

2. Six seismic shots were taken to back up the drilling information. The seismic survey indicated rock velocities well within the rippability range of a D9 hydraulic ripper or equivalent. Four of the seismic shots were taken in the borrow area. The four shots indicate that more than adequate borrow is available.

APPENDIX VII

STABILITY ANALYSES

10-58

SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY

SUMMARY - SLOPE STABILITY ANALYSIS

State Virginia Project Beaver Creek Site #80

Date 12-30-64 Analysis Made By T.C.H. Checked By G.L.M.

Method of Analysis Swedish Circle

		#1	#2	#3	
Location of Material		Emb 115 PCF GM	Emb 100% Std GM	Emb 100% Std GM	
Sample No.		65F223	65F224	65F225	
γ_d		117.1	114.0	108.0	
γ_m		128.5	127.0	127.5	
γ_s		134.0	128.5	128.5	
γ_b		71.5	66.0	66.0	

Condition	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.
ϕ				32.5°		30.5°		23.5°		
Tan ϕ			$\overline{CU}$	0637	$\overline{CU}$	0589	$\overline{CU}$	0435		
K										
C				600		675		1050		

UPSTREAM SLOPE

Trial	Slope	Conditions	Fs
1	2½:1	Full drawdown-10' berm @ el. 1551- Arc cut from opp shldr thru emb #1 only	1.54
1A	2½:1	Same as #1 except emb #2	1.51
1B	2½:1	Same as #1 except emb #3	1.65
2	2½:1	Full drawdown-10' berm @ el. 1551- Arc cut from opp shldr thru emb #2 only	1.50
2A	2½:1	Same as #2 except emb #1	1.52
3	2½:1	Full drawdown-10' berm @ el. 1551- Arc cut from opp shldr thru emb #2 only	1.56
3A	2½:1	Same as #3 except emb #1	1.57
4	2½:1	Full drawdown-10' berm @ el. 1551- Arc cut from mid top thru emb #2 only	1.51

DOWNSTREAM SLOPE

Trial	Slope	Conditions	Fs
5	2½:1	No drain- No berm- Arc cut from opp. shldr- thru emb #2 only	1.67
5A	2½:1	Same as #5 except emb #1	1.71
6	2½:1	No drain- No berm- Arc cut from opp. shldr thru emb #2 only	1.62
6A	2½:1	Same as #6 except emb #1	1.65
7	2½:1	No drain- No berm- Arc cut from opp. shldr thru emb #2 only	1.65
7A	2½:1	Same as #7 except emb #1	1.68
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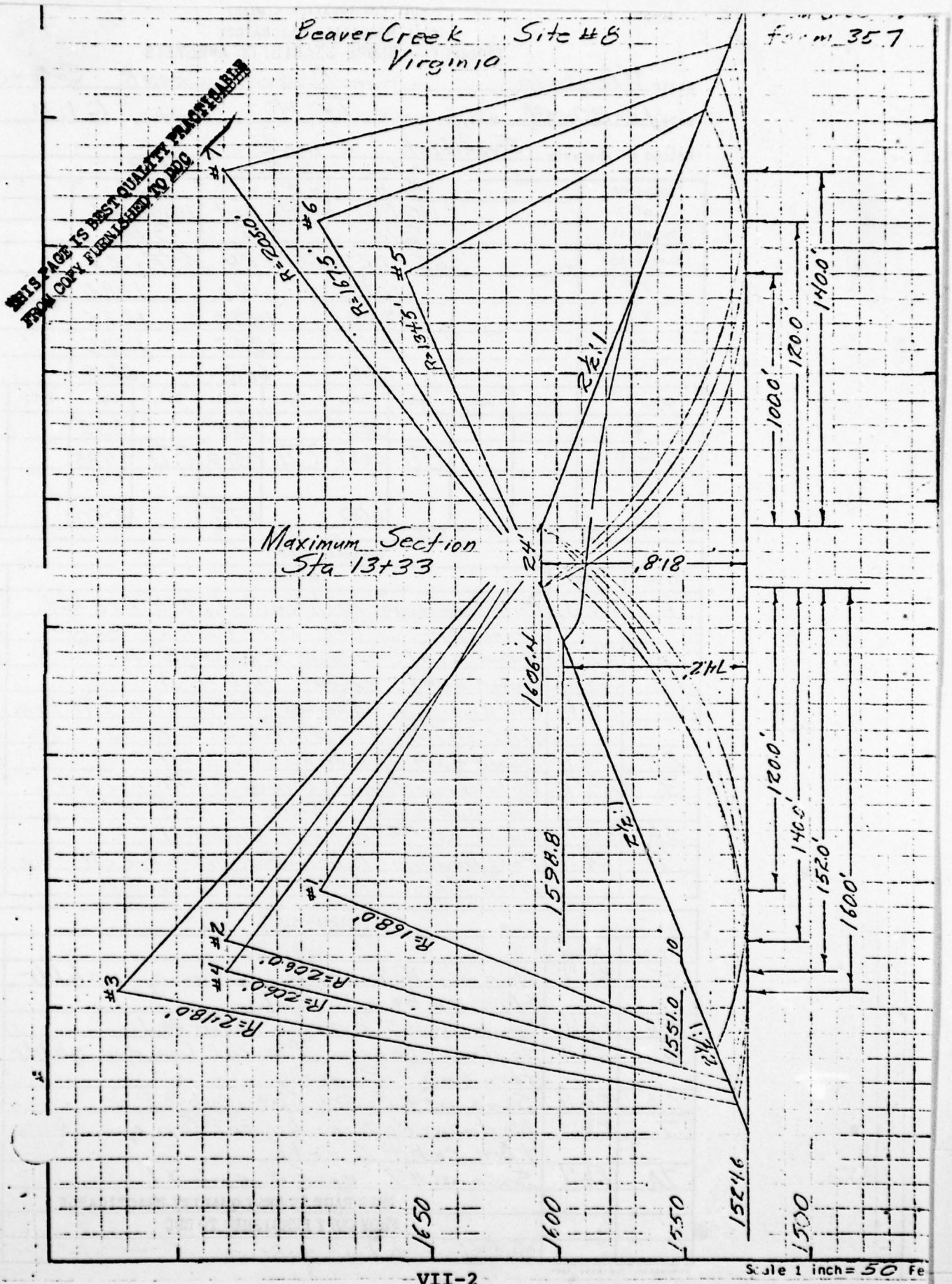
		Sat shear values only on all trials	


Beaver Creek Site #8
Virginia
form 357
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#1
#2
#3
#4
#5
R=200.0'
R=167.5'
R=1343.2'
R=168.0'
R=266.0'
R=266.0'
R=2118.0'
Maximum Section
Sta 13+33
24'
8'
18'
2%
1606.4
1598.8
1551.0
1521.6
22:1
2½:1
1:1½
1000'
120.0'
140.0'
120.0'
140.0'
152.0'
160.0'
1650
1600
1550
1500
Scale 1 inch = 50 Fe

SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY

SUMMARY - SLOPE STABILITY ANALYSIS

State VIRGINIA Project BEAVER CREEK SITE #80

Date 1-12-64 Analysis Made By G.J.M. Checked By T.C.H.

Method of Analysis SWEDISH CIRCLE

Location of Material										
Sample No.										
γ_d										
γ_m										
γ_s										
γ_b										
Condition	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.
ϕ										
Tan ϕ										
K										
C										

UPSTREAM SLOPE

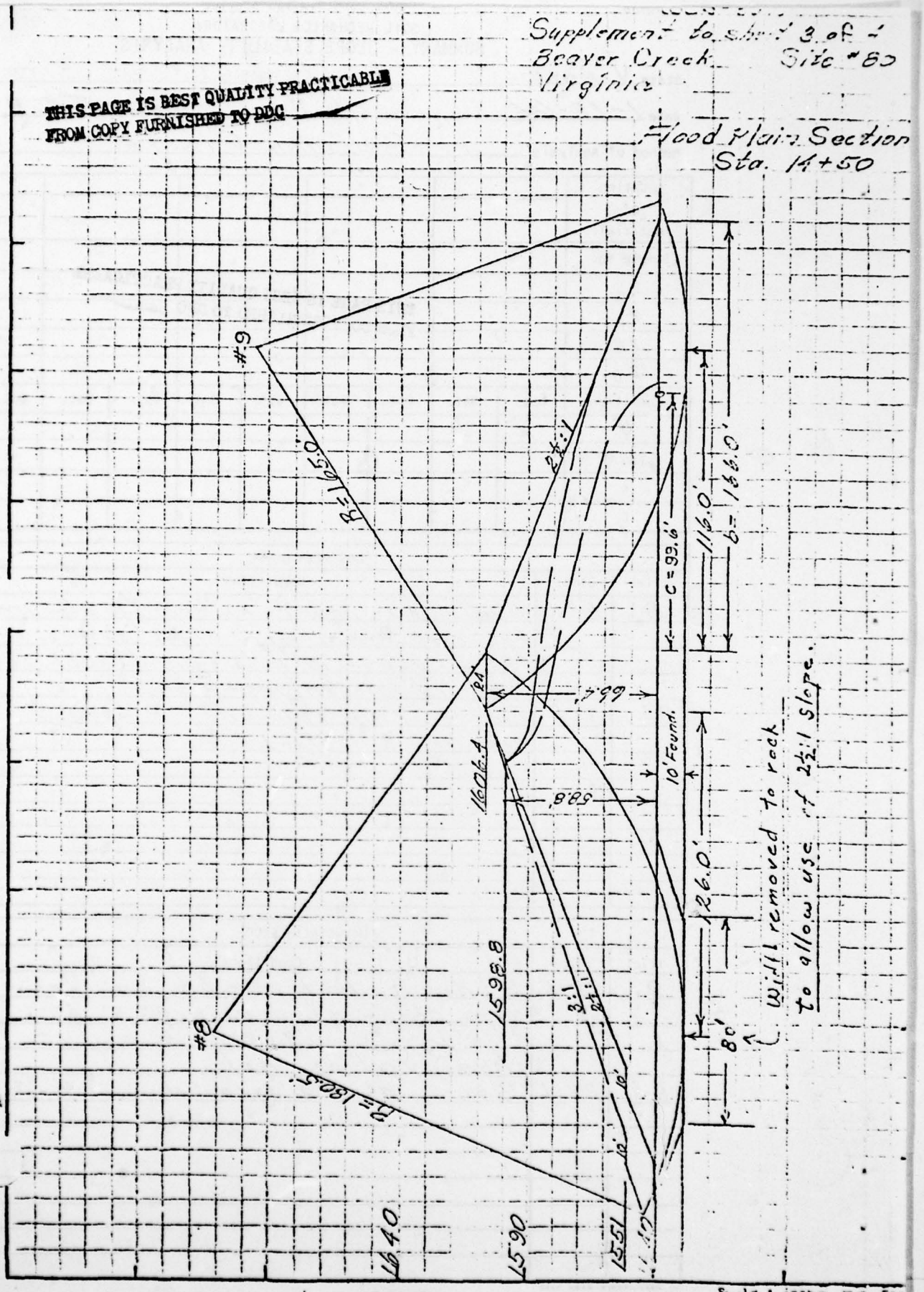
Trial	Slope	Conditions	Fs
8	2½:1	Full drawdown - 10' hor. @ elev 1551 - Arc cut from upp. shlr. thru emb. (32.5°-60°) & 10' into Found (32.5°-0°) - Sat. shear values only.	1.44
8A	3:1	Same condition as #8 except using 3:1 slope	1.47

DOWNSTREAM SLOPE

Trial	Slope	Conditions	Fs
9	2½:1	No drain - No berm - Arc cut thru upp. shlr. thru emb. (32.5° - 60°) & 10' into Found (32.5° - 0°) - Sat. shear values only.	1.32
9A	2½:1	Same as #9 except drain @ toe = 0.0	1.66

Supplement to Sheet 3 of 4
Beaver Creek Site #65
Virginia

Flood Plain Section
Sta. 14+50



Scale 1 inch = 50 Feet

APPENDIX VIII

PIPING AND CRACKING ANALYSIS

SCS-522 REV 5-58

STATE Va. PROJECT Rivanna #50

BY TOP DATE 3/23/65 CHECKED BY EJM DATE 4/15/65 JOB NO VA-350-E

SUBJECT PIPING & CRACKING SHEET 6 OF

Field No.	SAMPLE	DEPTH	U.S.C.S.	D_{50} m.m.	P.I.	L.L.	% .005 m.m.	PIPING *	CRACKING *	REMARKS
501.1	218	1-3'	SM	0.12			17			Foundation
501.2	219	3-6'	SM	0.25			17			"
502.1	220	1-3'	CL	0.0044			51			"
502.2	221	3-6'	SM	0.48			14			"
205.1	222	1-4'	GC	0.28	9	28	21	4	3	
205.2	223	4-10'	GM	8.2	11	37	13	4	3	
207.1	224	1-7'	GC-GM	2.8	8	31	19	4	3	
215.1	225	1-7'	GM	3.3	12	40	24	4	3	
219.1	226 "	1-7'	GM	0.084	22	52	36	5	5	
104.1	227 "	1-7'	GC	3.9	9	31	17	4	3	
107.1	228 "	1-4'	GM	10.2	8	33	11	4 or 2	3 or 4	
108.1	229 "	1-8'	SC-SM or GC-GM	0.145	6	25	23	1	2	
109.1	230 "	1-10'	SM	0.21	2	19	16	1	2	

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VIII-1

* DEGREE OF SUSSEPTABILITY (1 GREATEST TO 6 LEAST) TAKEN FROM "FLEXABILITY OF CLAY AND CRACKING OF EARTH DAMS" BY LEONARDS & NARAIN, ASCE PROCEEDINGS VOL. 89, SM 2, MARCH 1963, PP 50 & 51

" Eliminated as a source of borrow.